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Abstract

SOME STUDIES CONCERNING STRUCTURE, RADIATION DAMAGE ANNEALING AND FISSION PRODUCT DIFFUSION IN PYROLYTIC CARBON

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A number of studies on pyrolytic carbon were performed in order to contribute to the general understanding of this material.

Its structure was characterized mainly by neutron diffraction; data on preferred orientation, porosity, layer order, and crystallite dimensions, perpendicular and parallel to deposition planes, were obtained. The specific advantages of neutron diffraction methods against the corresponding X-ray techniques are discussed.

The investigated materials include various pyrolytic carbon samples which have been treated at different temperatures ($2000^{\circ}C$ - $3000^{\circ}C$) after deposition and also a sample of amorphous cellulose carbon.

The samples, previously characterized by diffraction methods, were irradiated at $78^{\circ}K$ up to fast neutron doses ($E>1$ MeV) of 10^{18} cm^{-2}. Subsequent recovery of electrical resistivity and structural parameters was carried out in order to identify annealing stages and to interpret the recovery process.

In other samples, having the same characteristics, the diffusion of some fission products (Zr, Nb, Xe, Cs, Ba) has been studied, by measuring both the diffusion coefficients and the probabilities of evaporation from the surface.

In the experimental procedure fission fragments are injected into the sample by fission recoil from a thin uranium foil and their distribution and the escaped fraction after heating at high temperature are measured.

The influence of the diffusion and evaporation processes on the loss of the above elements is discussed.

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ZIRCALOY-2 PRESSURE TUBE CORROSION

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Over the past three years the Technological Laboratory of CISE has been investigating the corrosion of Zircaloy-2 by steam-water mixture at high mass velocity. The aim of this research is to investigate the suitability of Zr alloys for cladding or pressure tubes when steam-water flowing mixtures are used as cooling agents.

In other words, we want to check the presence and the importance of erosion phenomena and of the corrosion rate increase in comparison with the static conditions. The data collected up to now have proved the suitability of Zircaloy-2 for use in the presence of two-phase mixtures in the overall range of mass velocities and qualities requested by the technical appliances. Actually neither erosion effects nor dangerous corrosion rates on the walls of the tubular samples were observed.

However, a limited but clearly discernible acceleration of the corrosion rate has been detected in the tubular samples through which a steam water mixture flows. This phenomenon presents more a scientific rather than technical interest. Nevertheless, we felt it convenient to develop further researches in this field so as to find the cause and the mechanism of this acceleration. This investigation is probably worth while for the elimination of some difficulties which have arisen during the interpretation of this effect.

At present, the conclusion has been reached that the origin of this phenomenon has to be sought in the pressure existing inside the tubular test elements, rather than in the flowing state of the two-phase mixture. We point out that our samples reproduce the working conditions of some actual fuel element cladding.

This interpretation has so far been supported by the results of several experiments and opens a new field of investigation for determining the exact influence of this phenomenon under different pressure and temperature conditions.

The study of corrosion under dynamic conditions has been extended to tests with either oxygen or hydrogen added to the mixture, and a thorough examination of the samples was made, by using both the optical and the electronic microscope and by measuring the electrical capacity and resistivity of the oxide layer in order to detect possible differences in the physical properties of the oxide formed under static and dynamic conditions.